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PRENATAL EXPOSURE TO AN ELF ROTATING MAGNETIC FIELD, AMBULATORY BEHAVIOR, AND LUNAR DISTANCE AT BIRTH: A CORRELATION[1]

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Summary.—A significant correlation of .877 between lunar distance at the time of birth and the number of squares traversed in a open-field situation 21 to 25 days later was found for 19 litters that had been exposed continuously during their prenatal development to a 0.5 Hz, 3 to 30 gauss Rotating Magnetic Field (RMF), over a year. RMF-exposed litters that were born on or near lunar perigees traversed fewer squares in an open field than those born on or near apogees. RMF-exposed litters tested "blind" also showed the relationship between lunar distance at time of birth and later open-field activity. 12 control litters did not show a significant correlation (.101).

Especially low-frequency (ELF) electromagnetic fields (0.1 to 50 Hz) occur in nature (Konig, 1962). Data suggest that these fields originate from unstable meteorological conditions, geomagnetic pulsations, as well as other environmental sources. ELF electromagnetic fields, depending upon their frequencies, have been shown to affect reaction time of human *Ss* (Konig, 1962; Friedman, Becker, & Bachman, 1967; Reiter, 1963) and ambulatory behavior in infra-human species (Altmann, 1969; Dowse & Palmer, 1969). Persinger (1969) demonstrated that the developing organism is also susceptible to ELF electromagnetic fields. Rats which were continuously exposed during their prenatal development to a 3- to 30-gauss, 0.5 Hz, Rotating Magnetic Field (RMF), traversed significantly fewer squares (on the average) in an open field at 21 to 25 days of age. RMF-exposed rats also showed significantly fewer lever presses in a Sidman avoidance situation (Persinger & Foster, 1970).

However, the results of the open-field experiments suggested the presence of a previously unreported and unexpected correlation that must be taken into consideration if the RMF-exposure-ambulatory behavior data are to be replicated. The first six RMF-exposed litters, which were bred over a 3-mo. period, displayed more variance in their ambulatory behavior than the controls. In an attempt to isolate the source of variance, the numbers of squares traversed by litters in both conditions were plotted as a function of various physical environmental factors that varied during or after the time of exposure. Surprisingly, the largest and significant correlation was with lunar distance (as defined by the days before or after perigees) at the time the RMF-exposed litters were born. This relationship did *not* hold for the control litters. It was decided to test the reliability of the correlation by (1) testing RMF-exposed and control litters which had been specifically bred to be born on certain days with respect

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to lunar perigees (or apogees), (2) using a 'sham' RMF, and (3) testing these litters "blind," i.e., *Es* did not know which litters were RMF-exposed and which were control.

METHOD

A detailed description of the method used in this experiment can be found elsewhere (Persinger, 1969). Essentially, pregnant females, bred over a year period, were exposed to a 3- to 30-gauss, 0.5-Hz RMF. The RMF was created by two horseshoe magnets rotating in opposite direction about their major axes. The poles of the magnets were parallel to the earth's surface at Knoxville, Tennessee, and aligned in a NW-SE direction. At birth, the females and pups (6 to 8 per litter) were removed from the experimental and control conditions. When the pups were 21 days of age, they were tested for 2 min. in an open field for 5 consecutive days.

Since RMF-exposed litters 1 to 6 and control litters 1 to 6 (which had initially shown the correlation between lunar distance at birth and later open-field activity) had been bred without regard for lunar distance at birth, females, beginning with RMF-exposed litter 7 and control litter 7, were bred to give birth on specific days before or after perigees and apogees. Control litters 4 to 6 had been exposed to the running apparatus with the magnets removed (sham-RMF), and RMF-exposed litters 15 to 19 and control litters 10 to 12 were tested "blind" by two technicians. In total, 19 RMF-exposed litters and 12 control litters were tested.

RESULTS

Table 1 shows the litter numbers, dates of birth, and the mean and median

TABLE 1

LITTER NUMBERS, BIRTH DATES, MEAN SQUARES TRAVERSED, AND MEDIAN SQUARES TRAVERSED FOR RMF-EXPOSED AND CONTROL LITTERS

RMF-exposed Litters				Control Litters			
Litter	Birth Date	$M_{squares}$	$Mdn_{squares}$	Litter	Birth Date	$M_{squares}$	$Mdn_{squares}$
1	28/12/67	9.0	0	1	28/12/67	28.9	33
2	28/12/67	5.4	1	2	28/1/68	25.2	26
3	29/1/68	22.5	24	3	29/1/68	27.6	28
4	29/1/68	13.5	8	4	3/3/68	27.5	26.5
5	6/4/68	30.3	34	5	3/3/68	39.5	41.5
6	7/4/68	28.7	26.5	6	3/3/68	34.5	38.5
7	11/4/68	4.0	4	7	12/4/68	31.7	34
8	11/5/68	4.0	0	8	12/5/68	34.1	35
9	11/5/68	5.4	0	9	22/7/68	23.6	28
10	17/5/68	22.0	27.5	10	21/12/68	37.2	44
11	17/5/68	17.6	18	11	22/12/68	19.0	22
12	20/7/68	26.3	32	12	23/12/68	20.0	20
13	21/7/68	40.6	42.5				
14	18/8/68	28.5	28.5				
15	18/8/68	31.8	31.5				
16	18/8/68	21.9	24				
17	20/12/68	4.0	0				
18	23/12/68	10.3	4				
19	23/12/68	26.4	20				

squares traversed in the open field from 21 to 25 days of age for RMF-exposed and control litters. (The median squares traversed during the five days for each rat in a litter was the value used to compute the median and mean squares traversed by the litter.) Fig. 1 shows the relationship between ambulatory behavior (median squares traversed) of the litters as a function of the days before or after the nearest perigees ("P") that the litters were born. To facilitate correlational computation, open-field scores for litters born on days before perigees are juxtaposed with the scores of the litters born on days after perigees. Since perigees were used as the reference point, apogees, which varied about the former by 11 to 16 days, are not marked. It can be seen that the 19 RMF-exposed litters (open circles) born on or near days of various perigees ("P") traversed almost no squares in the open field. However, as the RMF-exposed litters were born on days nearer and nearer lunar apogees, they traversed more squares. The 12 control litters (closed circles) did *not* show this relationship. The RMF-exposed litters (○) showed a significant correlation of .877 between median squares traversed and lunar distance at the time of birth ($t = 7.66, p < .001$). The control litters (●) showed a correlation of .101, which was not significant ($t = .32, p > .10$).

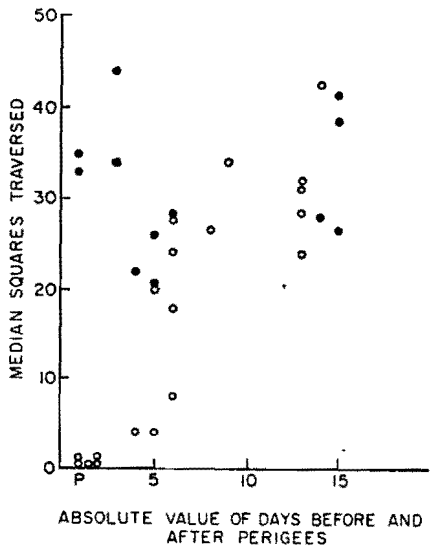

FIG. 1. Median squares traversed when the litters born on days before the nearest perigrees are juxtaposed with litters born on days after the nearest perigees. RMF-exposed litters are indicated by the open circles (○) while the control litters are indicated by the closed circles (●).

The results seem to indicate that there is some relationship between RMF exposure, lunar distance at birth, and consequent ambulatory behavior. These results also held when more rigid control procedures were instituted. RMF-exposed litters 15 to 19 and control litters 10 to 12, which were run "blind," had open-field scores similar to litters born at similar lunar distances observed by *E*. Control litters 3 to 6, which had been exposed to a sham RMF, exhibited similar open-field behavior to that of other controls.

It should be emphasized that the relationship between lunar distance at birth and open-field behavior for the RMF-exposed animals is *only* a correlation. No doubt there was some environmental variable(s) which varied during the exposure and was in turn correlated with lunar distance, that is, more closely associated with the observed effect.

The reader is urged to remember that ambulatory behavior in the open field is subject to influence by many often subtle variables. Despite the use of extra control procedures in this study, the data should remain on a probationary status until replications in other laboratories are completed. Hopefully this challenge will produce a greater interest in the potential behavioral effects of the geophysical-meteorological environment.

REFERENCES

ALTMANN, G. Die physiologische Wirkung elektrischer Felder auf Organismen. *Arch. Met. Geoph. Bioklim., B.*, 1969, 17, 269-290.

DOWSE, H. B., & PALMER, J. D. Entrainment of circadian activity rhythms in mice by electrostatic fields. *Nature*, 1969, 222, 564-566.

FRIEDMAN, H., BECKER, R. O., & BACHMAN, C. H. Effect of magnetic fields on reaction time performance. *Nature*, 1967, 213, 949-956.

KOENIG, H. L. Ueber den Einfluss besonders niederfrequenter elektrischer Vorgaenge in der Atmosphaer auf die Umwelt. *Z. angew. Bader-u. Klimaheilk*, 1962, 9, 481-501.

PERSINGER, M. A. Open-field behavior in rats exposed prenatally to a low intensity-low frequency rotating magnetic field. *Develop. Psychobiol.*, 1969, 2, 168-171.

PERSINGER, M. A., & FOSTER, W. S. ELF rotating magnetic fields: prenatal exposure and adult behavior. *Arch. Met. Geoph. Bioklim., B.*, 1970, in press.

REITER, R. Welche atmosphaerisch-elektrischen Elemente koennen auf den Organismus einwirken? *Z. angew. Bader-u. Klimaheilk.*, 1963, 10, 161-193.

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